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ABSTRACT

This document describes mathematical programs on the basic concepts of algebra produced by Louisiana Public Broadcasting. Programs included are: (1) "Inverse Operations"; (2) "The Order of Operations"; (3) "Basic Properties" (addition and multiplication of numbers and variables); (4) "The Positive and Negative Numbers"; and (5) "Using Positive Exponents." Each program contains objectives, vocabulary, pre-program activities, discussion questions, follow-up activities, and student worksheets. Notes for the teacher are included where appropriate. (YP)

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THE POWER OF ALGEBRA

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THE POWER OF ALGEBRA

PROGRAM ONE

INVERSE OPERATIONS

A. SYNOPSIS

This program will:

- Explore the nature of variables: how letters, etc., are used as placeholders for numbers.
- Introduce the process of solving algebraic equations through forming equivalent equations.
- Demonstrate how Algebra is used in everyday life to solve problems.

B. VOCABULARY

NOTE TO THE TEACHER: Every formula is an equation.

VARIABLE . . . . a symbol, usually a letter, used to represent any element of a given set of more than one element; a place holder for a number.

OPERATION . . . addition, subtraction, multiplication and/or division of real numbers.

EQUATION . . . . any statement involving the relationship "is equal to . . . "

SOLUTION . . . . any number which makes the equation true.

EQUIVALENT EQUATIONS . . . equations which have the same solutions.

INVERSE OPERATIONS . . addition and subtraction are **inverse operations** of each other -- they "undo" each other; multiplication and division are **inverse operations** of each other -- they "undo" each other.

C. PRE-PROGRAM ACTIVITY

1. Have two students of comparable height stand back to back in front of the class. Ask: "Are their heights equal? How would we write this as an equation?" (Example: Height of J = Height of K)

   Then have one student stand on a book. Ask: "Are their heights still equal? What do we do to make their heights the same?"

D. DISCUSSION QUESTIONS

1. What is the main idea of the program?
2. Can you think of any real-life applications or examples of inverse operations?
3. Summarize what you learned in the lesson.
4. Give examples of variables in everyday life.
   (Examples: electric meter, a person's weight, odometer reading, checkbook balance, speedometer reading, change from a dollar after a purchase, etc.)

E. FOLLOW-UP ACTIVITIES

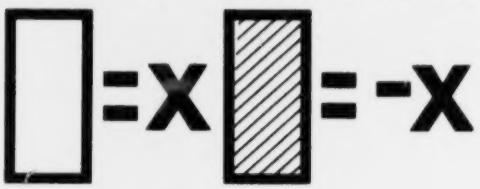
1. Balancing the Scale

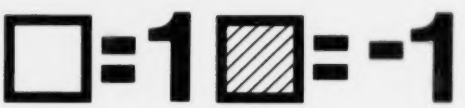
For this activity, you will need: a pan balance or a beam balance and appropriate weights (or common classroom objects). Show how the weight of two or more objects can be equal to the weight of a single object. Write this as an equation.
(Example: 2 + 3 = 5)

Place additional weight(s) on one side so that the scale becomes unbalanced. Discuss what must be done to balance the scales. Write this as an equation.
(Example: 2 + 3 + 1 = 5 + 1)

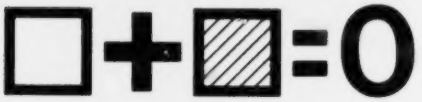
2. Using Algebra Tiles

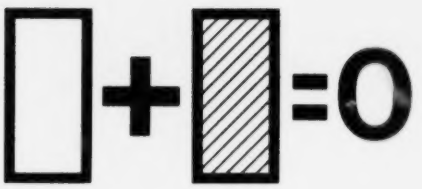
To solve equations using algebra blocks, use the following:



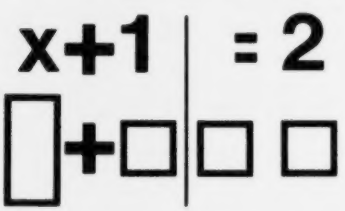


Remember that

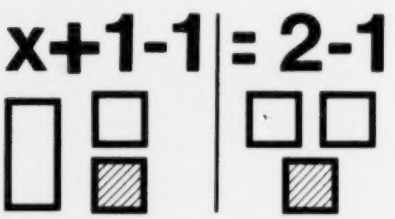




For the equation **X + 1 = 2**, display the blocks this way:



To solve the equation, you must get your **X** block alone. To do this, add a **negative 1** block ( ) to both sides. This gives you



3. Using the "Golden Rule"

NOTE TO THE TEACHER: Division by zero is impossible, since $\frac{a}{b} = b$ means $0 \cdot b = a$ but $0 \cdot b \neq a$. (EXAMPLE: $\frac{10}{2} = 5$ because $5 \cdot 2 = 10$, but $\frac{5}{0} \neq 5$ The answer is undefined.)

The **"GOLDEN RULE"** of equivalent equations is

DO UNTO ONE SIDE OF AN EQUATION
AS YOU WOULD DO TO THE OTHER.

This means when you add, subtract, multiply or divide (except when dividing by zero) on one side of an equation, you must perform the same operation on the other side.

For this activity, you will need an overhead projector or a blackboard. List the following examples and discuss them:

$X + 2 = 5$	(Subtract **2** from both sides)
$a - 7.2 = 12.5$	(Add **7.2** to both sides)
$3X = 10$	(Divide both sides by **3**)
$\frac{y}{4} = 5$	(Multiply both sides by **4**)

4. Discovering Equivalent Equations

NOTE TO THE TEACHER: It is important to understand that in the process of applying this method of solving equations, you move from one equation to an equivalent equation at each step.

a. Write the following groups of equations on the board:

$9 = X$

$X - 1 = 8$

$\frac{X}{3} = 3$

$5X = 45$

$3X + 2 = 29$

Discuss which ones are equivalent, and why.

b. Write the following equations on the board:

$a = 9$

$a - 1 = 10$

$2a + 5 = 40$

$\frac{a}{5} = 1$

$7a = 6$

Discuss why they are **not** equivalent.

5. Solving the Equations Which Appeared in the Program

NOTE TO THE TEACHER: When variables are on both sides of the equation, the "Golden Rule" works on the variable, too.

a. Write the following equations on the board:

$X + 150 = 180$

$X - 150 = 180$

$X \cdot 150 = 180$

$X \div 150 = 180$

$4X = X + 12$

$10X = 12(X - \frac{1}{4})$

$10X = 12X - 3$

Discuss how they were solved.
Explain how the "Golden Rule" applies.
Explain how you would use inverse operations to solve them.

NOTE TO THE TEACHER: The focus in this program is the use of inverse operations. Use of the distributive property will be discussed in a subsequent program.

b. Below are four charts used in the program to explain the **Rate · Time = Distance** problem Holmes solved. You may want to review this problem with the class as well.

RATE	·	TIME	=	DISTANCE
		X		
		$X-\frac{1}{4}$		

RATE	·	TIME	=	DISTANCE
		10	X	
		12	$X-\frac{1}{4}$	

RATE	·	TIME	=	DISTANCE
	10	X		$10X$
	12	$X-\frac{1}{4}$		

RATE	·	TIME	=	DISTANCE
	10	X		$10X$
	12	$X-\frac{1}{4}$		$12(X-\frac{1}{4})$

THE POWER OF ALGEBRA

PROGRAM TWO

THE ORDER OF OPERATIONS

A. SYNOPSIS

This program will:

- Define the order of operations for multiplication, division, addition and subtraction.
- Define the order of operations within grouping symbols relative to multiplication, division, addition and subtraction.
- Define exponents and the order of operations with exponents and grouping symbols.
- Discuss how these rules may be used to simplify algebraic problems.

B. VOCABULARY

FACTOR . . . . . if two numbers **a** and **b** are multiplied together to form a product **ab**, then **a** and **b** are called the **factors** of the product **ab.**

POWER . . . . . if the number **a** is used as a factor **n** times, the product may be written as a^n. A product of the form a^n is called a **power.**

In the **power** a^n, **a** is called the **base** of the power and **n** is called the **exponent** of the power.

NOTE TO THE TEACHER:

a) In the power a^n, n is called a superscript.

b) x_n is read "x sub n" where sub stands for subscript and is not the same as the power x^n.

OPERATION . . .addition, subtraction, multiplication or division of real numbers.

C. FOLLOW-UP ACTIVITY

1. "Please Excuse My Dear Aunt Sally." This phrase will help students remember the rules for order of operations. Put on the chalk board:

P

E

M D

A S

Say "Please Excuse My Dear Aunt Sally. This stands for

Parentheses

Exponents

Multiplication and Division

Addition and Subtraction."

Emphasize that multiplication and division have the same priority; that is, they are done from left to right as they occur in the expression. Addition and subtraction also have the same priority. That is why the letters which stand for multiplication/division and addition/subtraction are written on the same line.

2. Show how the addition of parentheses to a problem changes the problem.

$2 + 3 \cdot 5 - 8 \div 2^2$	$(2 + 3)5 - (8_2 \div 2)^2$
$2 + 3 \cdot 5 - 8 \div 4$	$(5)5 - 4$
$2 + 15 - 2$	$(5)5 - 16$
$17 - 2$	$25 - 16$
15	9

3. Explain the difference between -2^4 and $(-2)^4$.

-2^4 means	$(-2)^4$ means
$(-1)(2)(2)(2)(2)$	$(-2)(-2)(-2)(-2)$
-16	16

NOTE TO THE TEACHER: You may need to explain all the different ways that the operation of multiplication can be shown in algebra.

Ex. 2×3

$2 \cdot 3$

$2(3)$

$(2)(3)$

4. Review the rules of the Order of Operations.

a) First, perform the exponential operations.

Ex. $50 - 2^2 \cdot (2 + 3) \div 10$

$50 - 4 \cdot (2 + 3) \div 10$

b) Second, perform the operations inside grouping symbols.

Ex. $50 - 4 \cdot (2 + 3) \div 10$

$50 - 4 \cdot 5 \div 10$

c) Third, perform multiplication and division as they occur, starting on the left of the expression and moving to the right.

Ex. $50 - 4 \cdot 5 \div 10$

$50 - 20 \div 10$

$50 - 2$

d) Fourth, perform addition and subtraction as they occur, starting on the left of the expression and moving to the right.

Ex. $50 - 2$

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5. Show that a different result would have been obtained in (4) above if a different order of operations had been applied.

Ex. $50 - 2^2 \cdot (2 + 3) \div 10$	Perform the exponential operations.
$50 - 4 \cdot (2 + 3) \div 10$	Perform operations inside grouping symbol.
$50 - 4 \cdot 5 \div 10$	Perform multiplication.
$50 - 20 \div 10$	Perform subtraction.
$30 \div 10$	Perform division.
3	

6. Solve the equation which appeared in the program.

$$\frac{8}{16^2} = \frac{D_2}{20^2}$$

7. In the video, why is $X = 3 + 4 \cdot 2$ equal to 11 and not equal to 14? Also, why is $X = 3 + \frac{4}{2}$ equal to 5 and not equal to 3.5?

D. DISCUSSION QUESTIONS

1. Show how exponents can be used to write a product in simpler form.

Ex. $2 \cdot 2 \cdot 2 \cdot 5 \cdot 5 \cdot 7 \cdot 7 \cdot 7 \cdot 7 = 2^3 \cdot 5^2 \cdot 7^4$

2. Why is $8 - 6X + 5$ not equal to $2X + 5$?

3. The solution of the equation $2 + (4^2 + X) + 6X \div 3 = 26$ is a) 7, b) 2.68, c) $\frac{8}{3}$, d) 106.5. Why?

NOTE TO THE TEACHER:

1. **a^n is read as "a to the nth power." For example a^2 is read "a squared," a^3 is read "a cubed," and a^6 is read "a to the sixth power."**

2. **In discussing factors, it should be noted that the product ab is a multiple of a and also a multiple of b. We also call a and b divisors of the number ab.**

E. STUDENT WORKSHEETS

ORDER OF OPERATIONS #1 Name _____

Compute each of the following:

1. $2 + 3 \cdot 6$

2. $(2 + 3)6$

3. $10 \div 2 \cdot 3$

4. $10 \div (2 \cdot 3)$

5. $16 - 3 + 8$

6. $16 - (3 + 8)$

7. $6 + 24 \div 6 \cdot 2 - 4$

8. $[(6 + 24) \div 6] \cdot 2 - 4$

9. $12 \cdot 3 + 18 \div 3^2$

10. $12 \cdot 3 + (18 \div 3)^2$

E. STUDENT WORKSHEETS

ORDER OF OPERATIONS #2 Name _____

Simplify the following expressions:

1. $6 - [4X + 3(2 - X) \div 7]$

2. $16 \div (6 + 7)^2 + (-4)^2 + 6$

3. $\frac{2}{3} \cdot (4^2 + 7) - 16$

4. $(1.75)^2 + 9.4 \cdot 8.6$

5. $[16 \cdot 6 + 4]^2 - 14$

6. $[16^2 \cdot 6^2 + 4^2] - 14$

THE POWER OF ALGEBRA

PROGRAM THREE

BASIC PROPERTIES

A. SYNOPSIS

This program will:

- Explore the properties of addition and multiplication of numbers and variables.
- Explore a property of multiplication of variables and numbers that is linked with the addition of variables and numbers.
- Discuss how these properties may be used to simplify algebraic problems.

B. VOCABULARY:

COMMUTATIVE PROPERTY OF ADDITION . . . . . $a + b = b + a$

COMMUTATIVE PROPERTY OF MULTIPLICATION . . . . . $a \cdot b = b \cdot a$

ASSOCIATIVE PROPERTY OF ADDITION . . . . . $a + (b + c) + (a + b) + c$

ASSOCIATIVE PROPERTY OF MULTIPLICATION . . . . . $a \cdot (b \cdot c) = (a \cdot b) \cdot c$

DISTRIBUTIVE PROPERTY OF MULTIPLICATION WITH RESPECT TO ADDITION . . . . . $a \cdot (b + c) = a \cdot b + a \cdot c$

LIKE TERMS . . . . . **like terms** of an algebraic expression are the terms with exactly the same variable part.

Ex. **3a** and **6a** are **like terms,** but **3a** and $6a^2$ are <u>not</u> **like terms.**

SIMPLIFIED . . . . . an algebraic expression is **simplified** when like terms are combined by adding their numerical coefficients.

C. FOLLOW-UP ACTIVITIES

1. Show that the **commutative property of addition** verifies that $a = a + 0 = 0 + a$ for all numbers **a.** Because of this, **0** is defined as the **identity for addition.** Show that the **commutative property of addition** verifies that $0 = a + (-a) = (-a) + a$. Thus $-a$ is called the **additive inverse** of **a.**

2. Show how the **commutative** and **associative properties of addition** may be used to simplify algebraic expressions.

Ex. Simplify: $3a - 5 + 6a + 10$

$3a + 6a - 5 + 10$

$9a + 5$

Simplify: $(4y + 6) + (y + 7)$

$4y + (6 + y + 7)$

$4y + (6 + 7 + y)$

$4y + (13 + y)$

$4y + (y + 13)$

$(4y + y) + 13$

Simplify: $2X^2 - y + X^2 + 7$

$2X^2 + X^2 - y + 7$

$3X^2 - y + 7$

3. Show that the **commutative property of multiplication** verifies that

$$a = 1 \cdot a = a \cdot 1$$

Thus, 1 is called the **identity for multiplication.**

Also, show that the **commutative property of multiplication** verifies that

$$1 = a \cdot \frac{1}{a} = \frac{1}{a} \cdot a$$

if **a** is not equal to **0.**

Therefore, $\frac{1}{a}$ is called the **reciprocal of a** or the **multiplicative inverse of a.**

NOTE TO THE TEACHER: It is important that a is not equal to zero since $\frac{1}{0}$ is not defined.

4. Show how the **commutative** and **associative properties of multiplication** may be used to simplify algebraic expressions.

Ex. Simplify: $(6X) \cdot (3)$

$(6) \cdot (X \cdot 3)$

$(6) \cdot (3X)$

$(6 \cdot 3) \cdot X$

$18X$

5. Show how the **distributive property of multiplication with respect to addition** may be used to remove grouping symbols in an algebraic expression.

Ex. Simplify: $6(X + 7)$

$6(X) + 6(7)$

$6X + 42$

Simplify: $2(X^2 - 5X + 10)$

$2(X^2) + 2(-5X) + 2(10)$

$2X^2 - 10X + 20$

Simplify: $5(y + 7) + 6(2y + 4)$

$5(y) + 5(7) + 6(2y) + 6(4)$

$(5y + 35) + (12y + 24)$

$5y + (35 + 12y + 24)$

$5y + (12y + 35 + 24)$

$(5y + 12y) + (35 + 24)$

$17y + 59$

D. DISCUSSION QUESTIONS

1. Is the **commutative property** true for subtraction? If not, give a counter example.
2. Is the **commutative property** true for multiplication? If not, give a counter example.
3. Is $(a - b) - c = a - (b - c)$? If not, give a counter example.
4. Is $(a \div b) \div c = a \div (b \div c)$? If not, give a counter example.
5. What conclusions can you draw from (3) and (4)?
6. Is $-(2X + 5) = -2X - 5$? Why?
7. In the earlier example, why are $3a$ and $6a^2$ not like terms?

NOTE TO THE TEACHER:

a. **After discussion question (6), it should be stressed that a minus sign before a grouping symbol means that every item inside the grouping symbol must be multiplied by -1.**

b. **After discussing the additive and multiplicative identities and the additive and multiplicative inverses, it should be stressed that each of these is unique. That is, there is only one of each.**

c. **A counter-example is one example to show that a given statement is not true.**

Ex. Statement: All odd numbers are divisible by 3. (False.)

Counter-example: 11 is not divisible by 3.

E. STUDENT WORKSHEETS

BASIC PROPERTIES #1 Name _____

Simplify the following:

1. $2(a^2 - 5) + (3 - a) \cdot 6a$

2. $(x^2 + y^2) + (-x^2 - y^2)$

3. $3y(2x - 5) + x(2y - 5)$

4. $(x + y) \cdot (x - y)$

5. $(t - 5) \cdot (t - 6)$

6. $2x - 7[4x - 2(x + 10)]$

E. STUDENT WORKSHEETS

BASIC PROPERTIES #2 **Name** _____

State the rule which justifies the following statements:

1. $7 + (2 + 5) = (7 + 5) + 2$

2. $6 + 10 = 10 + 6$

3. $(x + y) \cdot 2 = 2x + 2y$

4. $(x + y) + 7 = (x + 7) + y$

5. $t \cdot (xy) = x \cdot (yt)$

Write a numerical example to illustrate each of the following properties:

1. Commutative Property of Addition

2. Commutative Property of Multiplication

3. Associative Property of Addition

4. Associative Property of Multiplication

5. Distributive Property of Multiplication over Addition

PROGRAM FOUR

THE POSITIVE AND NEGATIVE NUMBERS

A. SYNOPSIS

This program will:

- Explain the real number line and the effect of directions on the set of real numbers.
- Explore the relationship between positive numbers, negative numbers, and zero.
- Demonstrate the need and uses of positive and negative numbers.
- Use the real number line to define subtraction of real numbers.
- Define subtraction of signed numbers.

B. VOCABULARY

ZERO OR ORIGIN ON A NUMBER LINE . . . the point on the number line that is chosen as the starting point.

POSITIVE NUMBERS . . . those numbers which are coordinates of points to the right (or above) zero on the number line.

NEGATIVE NUMBERS . . those numbers which are coordinates of points to the left (or below) zero on the number line.

SIGNED NUMBERS . . . . the set consisting of all positive numbers, all negative numbers, and zero.

OPPOSITE OF A NUMBER . . . . . on a number line, any number can be paired with another number which is the same distance from **0** and on the opposite side of **0**. Such a pair of numbers is called **opposite.** Example: 3, -3

SUBTRACTION OF SIGNED NUMBERS . . . . to subtract one **signed number** from another, add the opposite of the number to be subtracted to the other number; i.e. if **a** and **b** are any two **signed numbers**, then **a - b = a + (-b)** .

GREATER THAN . . . . . lies to the right or above.

LESS THEN . . . . . lies to the left or below.

NOTE TO THE TEACHER:

a) Uses of the Symbol "-".

If a and b represent any two real numbers, then in the expression a - (-b) , the symbol "-" is used in two different ways. The first "-" which is located between the two real numbers indicates the operation of subtraction. The second "-" which is part of the number (-b) indicates the opposite of b and -(-b) means the opposite of (-b) which is b.

b) Notice that it is always possible to subtract one signed number from another. This can be summarized by saying that the set of signed numbers closed with respect to subtraction.

C. FOLLOW-UP ACTIVITIES

1. Use a football field to show the position of a team who got the ball on the 30-yard line, gained 8 yards on the first play, lost 3 yards on the second play, and gained 5 yards on the third play.

2. Show addition, subtraction, multiplication and division on the number line.

3. Show the rules for addition, subtraction, multiplication and division of signed numbers.

4. Show that for any real number a, $a + (-a) = 0$ and $(-a) + a = 0$. Thus each number in the pair $(a, -a)$ is called the **opposite** or the **additive** inverse or the **negative** of the other number and 0 is called the **additive identity** or the **identity element of addition.**

5. Show the multiplication property of 0; i.e. for every signed number a, $a \cdot 0 = 0$ and $0 \cdot a = 0$. This concept is very important in solving quadratic equations.

6. Show the multiplication property of 1; i.e. for every signed number a, $a \cdot 1 = a$ and $1 \cdot a = a$. Explain that 1 is called the **identity element of multiplication** or the **multiplicative identity.** This is very important in division of signed numbers. Also show that for every signed number a, $a(-1) = -a$ and $(-1)a = -a$.

7. Show division of signed numbers as a fraction or as multiplying by the reciprocal, i.e. for any two signed numbers a and b, $b \neq 0$, $a \div b$ means $\frac{a}{b}$ or $a(\frac{1}{b})$. Actually, $a \div b$ means find a number which when multiplied by b gives a, i.e. $a \div b$ or $\frac{a}{b}$ means find c such that $cb = a$.

8. Use (5) and (7) to show why division by 0 is impossible, since $a \div 0$ means find the number which when multiplied by 0 gives a. There is no such number since the product of any signed number and 0 is 0.

D. STUDENT WORKSHEETS

THE POSITIVE AND NEGATIVE NUMBERS #1

Name _____

1. Complete the chart with a signed number to indicate the difference in actual weight and normal weight for each child.

	Christy	Garrett	Ashley	B.J.	Erin	Liz	Jason	Annie
Normal Weight	21	16	39	42	19	40	101	105
Actual Weight	24	21	39	36	23	46	88	97
Difference	+3							

2. Write the symbol to represent the opposite of each number.

a. $+4\frac{1}{2}$ _____ d. $(8 - 8)$ _____

b. -8.4 _____ e. $-\frac{3}{4}$ _____

c. $-(-5)$ _____ f. $-[-(5 + 2)]$ _____

3. Select the greater of the two numbers.

a. -4 -9 c. 0 -10

b. -8 1 d. -1 1

D. STUDENT WORKSHEETS

THE POSITIVE AND NEGATIVE NUMBERS #1

Name _____

4. Simplify each expression:

a. $[(-2 + 3) + (-1)]$

b. $x + 2 = 5$

c. $0 = -8 + a$

d. $b + b = 0$

e. $-[-(-5)]$

f. $(-3) + (-2)$

g. $(-5) - (-2)$

h. $-8(8 + 4)$

i. $(-3 + 15)(0)$

j. $\frac{1}{8}(-16x)$

5. A football team gained 5 yards on the first play, lost 4 yards on the second play, and lost 3 yards on the third play. What was the net result?

THE POWER OF ALGEBRA

PROGRAM FIVE

USING POSITIVE EXPONENTS

A. SYNOPSIS

This program will:

- Define exponents using positive integers and scientific notation.
- Illustrate the usefulness of exponents.
- Discover the rules of using positive exponents.
- Reinforce the use of exponents in computing square and cubic measures.

B. VOCABULARY

VARIABLE . . . . a symbol, usually a letter, used to represent any element of a given set of more than one element; a placeholder for a number.

FACTOR . . . . . when two or more numbers or **variables** are multiplied to form a product, each number or **variable** is a **factor** of the product.

BASE . . . . . the term to be used as a **factor**; the term raised to an **exponent.**

EXPONENT . . . small raised number that tells how many times a **base** is to be used as a **factor** (or how many times the **base** is to be multiplied by itself).

POWER . . . . . a product in which the **factors** are identical; a number which is expressed by means of a **base** and an **exponent.**

SCIENTIFIC NOTATION . . . a system of using **exponents** to represent very large numbers.

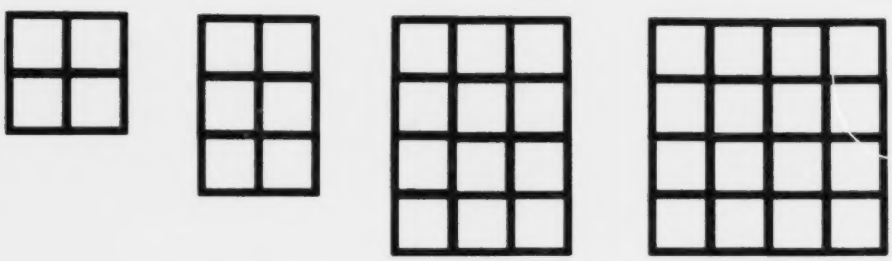
C. PRE-PROGRAM ACTIVITY

1. Give students 1 cm. grid paper. Have them draw a square with sides of 2. Write on the board 2^2. Have them count the number of blocks within the blocks. Show them that $2^2 = 2 \cdot 2 = 4$. Continue with 3^2, 4^2, etc.

   Display grids such as these. Ask the following questions:

   a) Do the following grids represent square numbers?

   b) If the answer is yes, what number is squared?



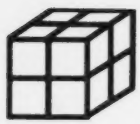
1) _____ 2) _____ 3) _____ 4) _____

C. PRE-PROGRAM ACTIVITY (Continued)

2. To show cubic numbers, give the students connecting blocks. Ask them to make a cube that is 2 blocks long, 2 blocks wide, and 2 blocks tall. Ask the students to count the number of blocks in the cube that they have made. Show them that $2^3 = 2 \cdot 2 \cdot 2 = 8$. Continue with building 3^3 and 4^3.

   Show figures such as the following on the overhead or blackboard. Ask which show cubic numbers and which do not. If the figure shows a cubic number, what is the number?

1) _____



2) _____

3) _____

4) _____

D. DISCUSSION QUESTIONS

1. What is the main idea of the lesson?
2. Summarize what you have learned in the lesson.
3. Can you think of any real-life applications or examples of **exponents**?
4. If 4^2 can be represented by a square with the length and width 4 and 4^3 can be represented by a cube with the length, width and height of 4, is there a way to physically represent 4^4 ? Why or why not?
5. Why is 3^2 not equal to 2^3 ?

E. FOLLOW-UP ACTIVITIES

1. Paper Folding

Have students fold a piece of paper in half one time. Write 2^1 on the board. Tell them that this means that you have folded the paper into 2 parts 1 time. How many parts do they have? $2^1 = 2$. Have them fold the paper in half a second time. Write 2^2 and ask them to count the parts. $2^2 = 4$. Continue folding a third and fourth time showing that $2^3 = 8$ and $2^4 = 16$. Do the same process with folding paper into thirds.

2. Exponential Chart

Give students a chart showing the patterns in exponential numbers.

Exponent Form	Read	Number
10^5	Ten to the fifth power	100,000
10^4	Ten to the fourth power	10,000
10^3	Ten to the third power	1,000
10^2	Ten to the second power, or ten squared	100
10^1	Ten to the first power	?

3. Practice for Exponents

Write in exponential form:

a) $5 \cdot 5$ _____

b) $4 \cdot 4 \cdot 4$ _____

c) $1 \cdot 1 \cdot 1 \cdot 1$ _____

Write the number:

a) 2^3 _____

b) 3^2 _____

c) 1^5 _____

d) 6^1 _____

E. FOLLOW-UP ACTIVITIES (Continued)

4. Practice for Scientific Notation

Complete the problem, writing the numbers in scientific notation.

$20{,}000 = ____ \times 10^4$	$320 = ____ \times 10^2$
$450{,}000 = ____ \times 10^5$	$3{,}500{,}000 = ____ \times 10^6$
$300{,}000 = 3 \times 10^{____}$	$400 = 4 \times 10^{____}$
$89{,}000 = 8.9 \times 10^{____}$	$535{,}000{,}000{,}000 = 5.35 \times 10^{____}$
$36{,}000 = ____ \times ____$	$8{,}000{,}000 = ____ \times ____$
$140 = ____ \times ____$	$4{,}000 = ____ \times ____$

5. Problems from the Program

$$10{,}000 \cdot 100 = _____$$

$$10^4 \cdot 10^2 = 10^6$$

Show students that $10^4 = 10 \cdot 10 \cdot 10 \cdot 10$ and $10^2 = 10 \cdot 10$

Multiplied together, $10^4 \cdot 10^2 = 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10$ or 10^6

$$10{,}000 \div 100 = _____$$

$$10^4 \div 10^2 = 10^2$$

Show students that $10^4 = 10 \cdot 10 \cdot 10 \cdot 10$ and $10^2 = 10 \cdot 10$

Divided, $10^4 \div 10^2 = \dfrac{10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10}{10 \cdot 10}$ or 10^2

$$17{,}000 \cdot 10^2$$

$$1.7 \cdot 10^4 \cdot 10^2$$

$$1.7 \cdot 10^6$$

E. FOLLOW-UP ACTIVITIES (Continued)

5. Multiplying and Dividing with Bases Other Than 10

Write $3^2 \cdot 3^1$ on the board. Show the students that this is the same as $3 \cdot 3 \cdot 3$ or 3^3 or 27. A short way to multiply powers is to add the exponents:

$$3^2 \cdot 3^1 = 3^{2+1} = 3^3 \text{ or } 27$$

Emphasize that the bases **must be** the same.

Show division in the same way:

$$5^5 \div 5^2 = \frac{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5}{5 \cdot 5} = 5^3 \text{ or } 125$$

The shortcut would be to subtract the exponents:

$$5^{5-2} = 5^3$$

Emphasize again that the bases must be the same.